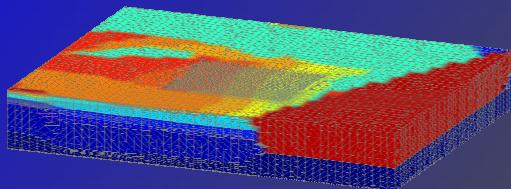


Mesh Generation For Geological Applications

Carl W. Gable

Hydrology Geochemistry & Geology, EES-6
Earth and Environmental Science Division
Los Alamos National Laboratory



EES-6 Hydrology Geochemistry & Geology



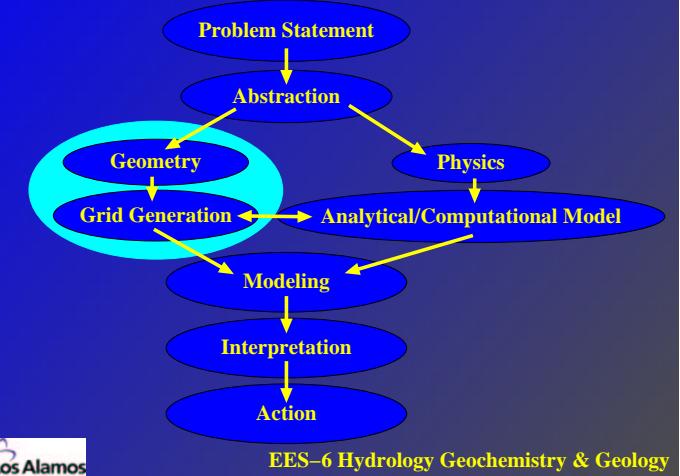
Grid Generation ↔ Computational Model

- | | |
|-------------------|--|
| Finite Difference | <ul style="list-style-type: none">– Orthogonal– Non-orthogonal– Constant vs. variable grid spacing |
| Finite Element | <ul style="list-style-type: none">– tri, quad, hex, tet, prism, pyramid– hybrid |
| – Finite Volume | <ul style="list-style-type: none">– Regular (finite difference like)– Arbitrary<ul style="list-style-type: none">> Voronoi> Median mesh> Polyhedra |
| Non-Simplex | <ul style="list-style-type: none">– Quadtree– Octree |



EES-6 Hydrology Geochemistry & Geology

Modeling and Geometry



EES-6 Hydrology Geochemistry & Geology

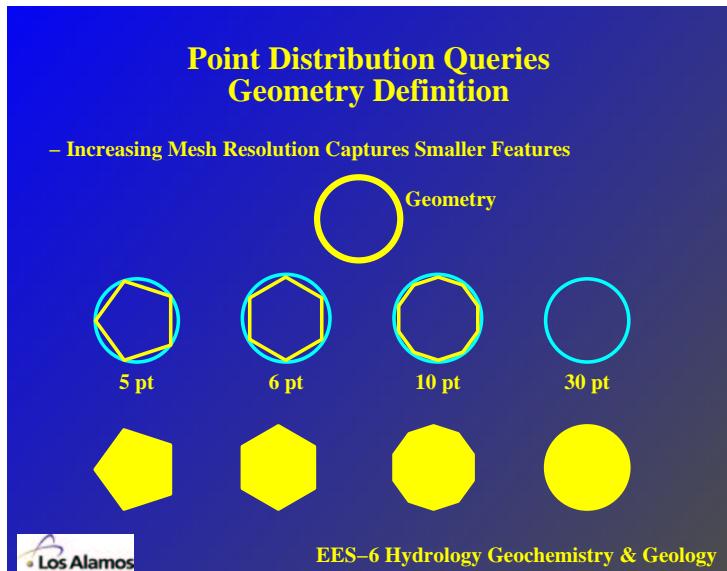
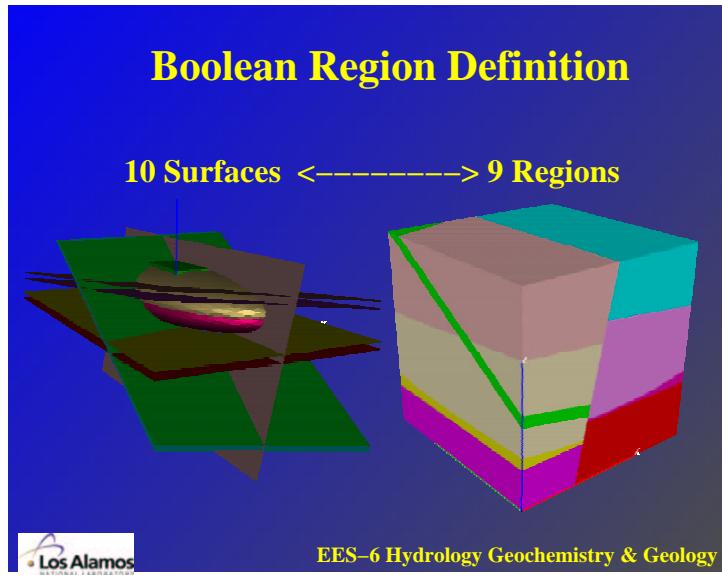
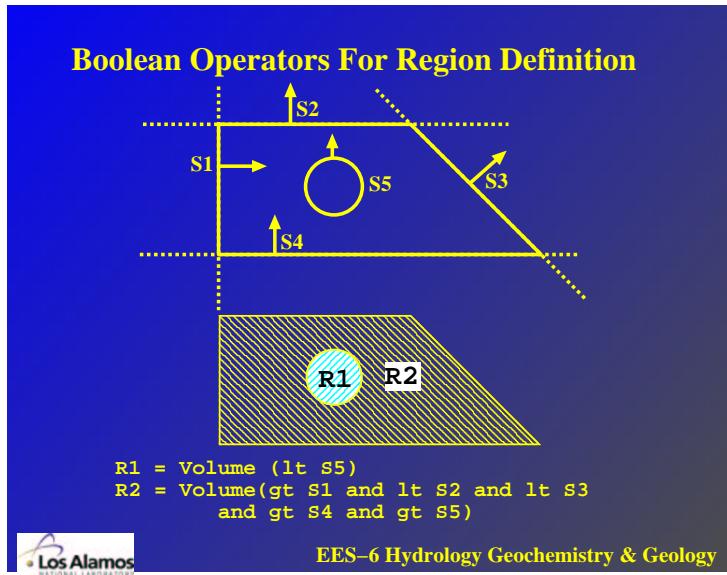
Geometry/Topology Definition

Constructive Solid Geometry

- Volumes bounded by surfaces
 - > Analytic Surfaces (cone, sphere, plane, etc)
 - > Splines, NURBS
 - > Tessellations (triangle surface)
- Cellular/Grid Volumes
- CAD Definition



EES-6 Hydrology Geochemistry & Geology



The Bottom Line

- Define Geometry Independent of Computational Mesh
- Mesh Generation Options are Increased
- Increased Grid Resolution Results in Increased Geometric Resolution
- Problem Definition is not Tied to Mesh

EES-6 Hydrology Geochemistry & Geology

Mesh Generation for Geological Applications

- Geometry is inferred, not designed
- High aspect ratio (100km x 10km)
- Physics needs more resolution than geometry
- Geometry not in CAD format

Mesh Requirements Are Application Specific

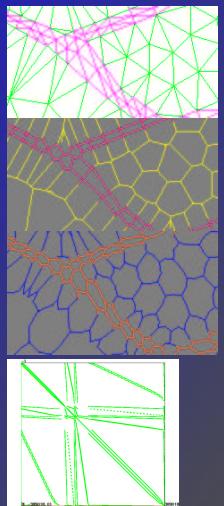
- Hydrology: compatible with conservative discretization schemes
- Shock Physics: Hex Mesh
- Lagrangian/Eularian
- Boundary layers



EES-6 Hydrology Geochemistry & Geology

LAGriT IO

- AVS, GMV, STL, FLOTTRAN, CHAD
- Control Volumes
 - Voronoi
 - Median
- Sparse Matrix
 - Area Coefficients
 - Volume Coefficients
 - Incidence Matrix (connectivity)
 - Matrix compression



EES-6 Hydrology Geochemistry & Geology

LAGriT: Los Alamos Grid Toolkit

LAGriT User Interface

- Command Line
- Batch Control Files
- Call by C and Fortran
- User defined modules
- No GUI

Access To Mesh Objects

- From C & Fortran
 - `get_information()`, `put_information()`
 - geometry, topology, properties
 - pointers to data structure entities
 - ascii, binary files



EES-6 Hydrology Geochemistry & Geology

LAGriT Geologic Model Input

- Stratamodel
- EarthVision
- GoCad
- ArcInfo, ArcGrid



EES-6 Hydrology Geochemistry & Geology

LAGriT: Mesh database management

– Topology

- add/delete nodes
- topology update (who is connected to whom)
- node <-> edge <-> face <-> element

– Attributes

- node, element
- integer, real
- scalar, vector, tensor

– Attribute Interpolation

- linear, log, ln, exp, arctan, arcsin, and, or, min, max,
- user_defn
- user_defn can provide attribute update for remapping
- grid to grid interpolation



EES–6 Hydrology Geochemistry & Geology

LAGriT

- Available as compiled libraries
- Registration and License procedures
- DEC, HP, LINUX (Absoft), SGI, SUN
- partial source available on request

www.t12.lanl.gov/home/lagrit



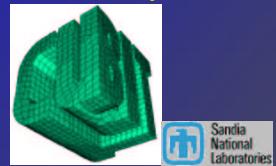
EES–6 Hydrology Geochemistry & Geology

Hexahedral Meshing

LAGriT

- Structured
- Block Structured
- Quadtree Refine
- Octree Refine

CUBIT – Sandia National Laboratory
(endo.sandia.gov/cubit)



EES–6 Hydrology Geochemistry & Geology

LAGriT: Los Alamos Grid Toolbox

Point Distribution

- xyz, rtp, rtz
- ray shooting
- read/write

Connectivity

- Delaunay Triangles and Tetrahedra
- Structured (i,j,k)
- Block Structured

Quality Improvement

- Smoothing
- Refine
- Derefine
- Graph Massage (refine/derefine/smooth)



EES–6 Hydrology Geochemistry & Geology